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Professional Profile

Dr. Carhart's expertise is in the biomechanics of human injury and accident reconstruction, specializing in the areas of musculoskeletal dynamics, occupant dynamics, human injury tolerance, vehicular rollover, and occupant-to-glazing interaction. He has a more than a decade of experience analyzing traumatic injuries associated with motor vehicles crashes, as well as incidents involving recreation, sport, falls, and the workplace.

Dr. Carhart has researched human motion, loading, and injury potential through the analysis and interpretation of the crash-test responses of anthropomorphic test devices (ATDs), the development and application of computational models of the human body, and statistical analyses. His research efforts in rollover include occupant protection system evaluations, the performance of vehicle roof structures, and the performance of automotive safety glass, with an emphasis on occupant motion, loading, containment, and injury mechanics. His efforts in these areas have involved computer modeling, component-level testing, and full-scale rollover testing. Dr. Carhart has also applied rehabilitation engineering approaches to affect functional recovery following spinal cord injury, including electrical stimulation and sensorimotor training.

Prior to joining Exponent, Dr. Carhart was a Research Scientist at the Arizona BioDesign Institute at Arizona State University (ASU), and a consultant with Forensic Dynamics, LLC. Dr. Carhart has undergraduate and graduate teaching experience in biomechanics, biomedical instrumentation, computer modeling, and microcomputer applications in bioengineering.

Academic Credentials & Professional Honors

Ph.D., Bioengineering, Biomechanics Emphasis, Arizona State University, 2000

B.S., Biomedical Engineering, Milwaukee School of Engineering, 1991

SAE Arch T. Colwell Merit Award, 2006

Sachiko Yahashi Memorial Award, International Society for Skiing Safety

Regent's Graduate Academic Scholar, ASU

Presidential Scholar, Milwaukee School of Engineering

Tau Beta Pi

Eta Kappa Nu

Phi Kappa Phi

Professional Affiliations

Society of Automotive Engineers—SAE

International Society of Biomechanics—ISB

American Society for Testing and Materials—ASTM

Southwestern Association of Technical Accident Investigators—SATAI

National Association of Professional Accident Reconstruction Specialists—NAPARS

The Institute of Electrical and Electronics Engineers—IEEE

The IEEE Engineering in Medicine and Biology Society—IEEE-EMBS

Patents

US Patent Application 20070129653: Spring-Over-Muscle Actuator, World Intellectual Property Organization WO/2004/096083, (with T. Sugar).

Publications

Miller, B., Dibb, A., Allin, L., Carhart, M. Krishnaswami, R. Seat Belt Restraint Evidence Generated by Unrestrained Occupant Interaction in a Rollover. SAE Int. J. Adv. & Curr. Prac. in Mobility 4(5):1642-1650, 2022, https://doi.org/10.4271/2022-01-0846.

Parenteau, C., Smedley, J., Campbell, I., and Carhart, M. Evaluation of Laminated Side Window Glazing Coding and Rollover Ejection Mitigation Performance Using NASS-CDS, SAE Technical Paper 2020-01-1216, 2020, https://doi.org/10.4271/2020-01-1216.

Parenteau, C., Smedley, J., Carhart, M., and Dibb, A. The Effect of Obesity on Rollover Ejection and Injury Risks. SAE Technical Paper 2020-01-1219, 2020, https://doi.org/10.4271/2020-01-1219.

Miller B, Smedley J, Carhart M, Sharpe S, Krishnaswami R. Evaluation of laminated side glazing and curtain airbags for occupant containment in rollover. SAE Technical Paper 2020-01-0976, 2020, https://doi.org/10.4271/2020-01-0976.

Heller M, Sharpe S, Newberry W, Dibb A, Zolock, J, Croteau, J, Carhart, M., et al. Occupant kinematics and injury response in steer maneuver-induced furrow tripped rollover testing. SAE International Journal of Transportation Safety 2015; 3(2). doi:10.4271/2015-01-1478.

Newberry W, Imler S, Carhart M, Dibb A, et al. Belted occupant kinematics and head excursion during the airborne phase of vehicle rollover: evaluation of the effects of rollover-deployed curtain airbags. SAE World Congress, 2014-01- 0527, Society of Automotive Engineers, Warrendale, PA, 2014.

Moralde M, Dibb A, Smedley J, Carhart M, Cooper E. Seat belt restraint evidence generated in the presence of fractured glass. SAE World Congress, 2012-01-0084, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2012.

Newberry W, Carhart M, Larson R, Bridges A, Fowler G. Biomechanics of occupant responses during recreational off-highway vehicle (ROV) riding and 90-degree tip-overs. SAE World Congress, 2012-01-

0096, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2012.

Heller M, Newberry W, Smedley J, Eswaran S, Croteau J, Carhart M. Occupant kinematics and injury mechanisms during rollover in a high strength-to-weight ratio vehicle. SAE World Congress, 2010-01-0516, Society of Automotive Engineers, Warrendale, PA, 2010.

Raasch C, Carhart M, Ivarsson BJ, Lucas S. Development of lower neck injury assessment reference values based on comparison of ATD and PMHS tests. SAE World Congress, 2010-01-0140, Society of Automotive Engineers, Warrendale, PA, 2010.

Welch T, Bridges A, Gates D, Heller M, Stillman D, Raasch C, Carhart M. An evaluation of the BioRID II and Hybrid III during low- and moderate-speed rear impact. SAE World Congress, 2010-01-1031, Society of Automotive Engineers, Warrendale, PA, 2010.

Richards D, Carhart M, Scher I, Thomas R, Hurlen N. Head kinematics during experimental snowboard falls: Implications for snowboard helmet testing. Journal of ASTM International 2008; 5(6), Paper ID JAI101406.

Scher I, Richards D, Carhart M, Thomas R, Hurlen N, Lam T. Pediatric head and neck injuries in snow sports: Evaluating the influence of helmets. Journal of ASTM International 2008; 5(4), Paper ID JAI101400.

Heller M, DiJorio S, Kuzel M, Carhart M, Ciccarelli L. Effect of shoe type on kinematics of stair negotiation in women. Proceedings, International Conference on Contemporary Ergonomics, April 2008.

Luepke P, Carhart M, Croteau J, Morrison R, Loibl J, Ridenour J. An evaluation of laminated side window glass performance during rollover. SAE World Congress, 2007-01-0367, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2007.

Pierce J, Carhart M, Bare C, Blakeslee A, Heald J. Retention characteristics of production laminated side windows. SAE World Congress, 2007-01-0376, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2007.

Ashby B, Lai W, Carhart M, Newberry W, Weaver B, Corrigan C. Compressive neck preloading during the airborne phase of vehicle rollover. SAE World Congress, 2007-01-0377, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2007.

Raasch C, Carhart M. Comparison of ATD upper and lower neck flexion/extension moments, and implications for neck injury criteria. 5th World Congress on Biomechanics, Munich, Germany, July 29-August 4, 2006.

Richards D, Carhart M, Raasch C, Pierce J, Steffey D, Ostarello A. Incidence for thoracic and lumbar spine injuries for restrained occupants in frontal collisions. Proceedings, 50th Annual Association for the Advancement of Automotive Medicine, Chicago, IL, October 16-18, 2006.

Newberry W, Lai W, Carhart M, Richards D, Brown J, Raasch C. Modeling the effects of seat belt pretensioners on occupant kinematics during rollover. SAE World Congress, 2006-01-0246, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2006.

Yamaguchi G, Ashby B, Lai W, Carhart M, Richards D, Corrigan C. Occupant mechanics in rollover simulations of high and low aspect ratio vehicles. SAE World Congress, 2006-01-0451, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2006.

Scher I, Richards D, Carhart M. Head injury in snowboarding: Evaluating the protective role of helmets. Journal of ASTM International 2006; 3(4), April (Paper ID JAI14203). Also in: Skiing Trauma and Safety,

Sixteenth Volume, ASTM STP 9034, 2006.

Huang H, He J, Herman R, Carhart M. Modulation effects of epidural spinal cord stimulation on muscle activities during walking. IEEE Transactions on Neural Systems and Rehabilitation Engineering 2006; 14(1), March.

Scher I, Richards D, Carhart M. Head contact after catching an edge: An examination of snowboarding helmets. Knee Surg Sports Traumatol Arthrosc 2006; 14.

Ganley K, Willis W, Carhart M, He J, Herman R. Epidural spinal cord stimulation improves locomotor performance in Low ASIA C, wheelchair-dependent, spinal cord-injured individuals: Insights from Metabolic Response. Topics in Spinal Cord Injury Rehabilitation 2005; 11(2), Fall.

Richards D, Scher I, Vijayakumar V, Carhart M, Larson R, Taylor S, Corrigan C. Repetitive head loading: Accelerations during cyclic, everyday activities. Proceedings, 20th Congress of the International Society of Biomechanics, July 2005.

Scher I, Richards D, Vijayakumar V, Carhart M, Corrigan C, Jaekel D. Coronal head accelerations during vigorous activities of daily living. Proceedings, Summer Bioengineering Conference, American Society of Mechanical Engineers, June 2005.

Lai W, Ewers B, Richards D, Carhart M, Newberry W, Corrigan C. Evaluation of human surrogate models for rollover. SAE World Congress, SAE 2005-01-0941, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2005.

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Yamaguchi G, Richards D, Larson R, Carhart M, Cargill R, Lai W, Corrigan C. Development of a computational method to predict occupant motions and neck loads during rollovers. SAE World Congress, SAE 2005-01-0300, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2005.

Yamaguchi G, Carhart M, Larson R, Richards D, Pierce J, Raasch C, Scher I, Corrigan C. Electromyographic activity and posturing of the human neck during rollover tests. SAE World Congress, SAE 2005-01-0302, and Transactions Journal of Passenger Cars, Society of Automotive Engineers, Warrendale, PA, 2005.

Carhart M, He J, Herman R, D'Luzansky S, Willis W, Dilli S. Epidural spinal cord stimulation facilitates functional walking recovery following incomplete spinal cord injury. IEEE Transactions on Neural Systems and Rehabilitation Engineering 2004; 12(1), March.

Willis W, Carhart M, D'Luzansky S, Thompson A, He K, Thresher K, Herman R. Metabolic and performance effects of electrical stimulation of the spinal cord and peripheral nerve on locomotion. Society for Neuroscience Abstracts, Program No. 824.17, 2003.

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Kuchi P, Hiremagalur R, Huang J, Carhart M, He J, Panchanathan S. DRAG: A database for recognition and analysis of gait. Proceedings, International Society for Optical Engineering (SPIE), Vol. 5242, November 2003.

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Carhart M. Biomechanical analysis of compensatory stepping: Implications for paraplegics standing via functional neuromuscular stimulation. Ph.D. Dissertation, Arizona State University, 2000.

Carhart M, Yamaguchi G. Estimation of muscle forces in normal human gait: Evaluation of the pseudoinverse method. Annals of Biomedical Engineering, Annual Fall Meeting of the Biomedical Engineering Society, Seattle, WA, 2000.

Carhart M, Yamaguchi G. Biomechanical analysis of compensatory stepping: Implications for paraplegics standing via functional neuromuscular stimulation. Annals of Biomedical Engineering, 2000.

Carhart M, Yamaguchi G. Exploring the feasibility of reactive stepping in paraplegics. 1st Annual Conference of the International Functional Electrical Stimulation Society (IFESS), 1996.

Carhart M, Yamaguchi G. Preparatory postural adjustments in perturbation induced stepping: A comparison to gait initiation. Neuroscience Abstracts, Vol. 1, No. 275.4, 1995.

Carhart M and Yamaguchi G. The motor control of stepping responses to postural perturbations. Proceedings, 19th Annual Meeting of the American Society of Biomechanics, 1995.

Carhart M, Yamaguchi G. The motor control of stepping responses to perturbations of posture: The automatic component. Annals of Biomedical Engineering, No. 319, 1994.

Carhart M, Yamaguchi G and Green J. Dynamic balance recovery: Stepping responses to postural perturbations. Proceedings, 17th Annual Meeting of the American Society of Biomechanics, 1993.

Presentations

Carhart, M. Helmets: Head protection, testing, and injury analysis. Sporting Goods Manufacturers Association (SGMA), Las Vegas, NV, April 2012.

Smedley J, Carhart M. Glazing and the rollover environment. SAE 2010 World Congress, Detroit, MI, April 15, 2010.

Carhart, M. Automotive side window glazing and occupant injury in rollover. ASM International, Phoenix Arizona Chapter Meeting, November 2008.

Scher I, Richards D, Carhart M, Thomas R, Lam T. Pediatric head and neck injuries: Evaluating the influence of helmets. 17th International Symposium on Skiing Trauma and Safety, Aviemore, Scotland, May 2007.

Richards D, Scher I, Carhart M. Kinematics of a snowboard fall: Implications for snowboard helmet testing. 17th International Symposium on Skiing Trauma and Safety, Aviemore, Scotland, May 2007.

Carhart M, Pierce J. Back to the basics: The inescapable physics of the rollover environment. American Bar Association, Emerging Issues in Motor Vehicle Products Liability Litigation, Phoenix, AZ, March 2007.

Carhart M. Analysis of prior glazing research: A biomechanical perspective. American Bar Association, April 2006.

Richards D, Carhart M, Scher I. A comprehensive look at helmet safety. Winter Conference of the National Ski Area Association, March 2006.

Richards D, Scher I, Carhart M. Snow helmets and head injury. Summer Meeting of ASTM Committee F27, 2005.

I Scher, D Richards, M Carhart. Head contact after catching an edge: An examination of snowboarding helmets. 16th International Symposium on Skiing Trauma and Safety, Arai, Niigata, Japan, April 2005.

Carhart M. Litigating the technical issues—Case studies in fires, explosions and biomechanics. Guest Faculty Member, Maricopa County Bar Association, October 13, 2004.

Carhart M. Changes in gait patterns with treadmill training and epidural spinal cord stimulation: Does biomechanics tell the story? Symposium on Motor and Metabolic Control During Walking, 23rd Annual Meeting, Southwest American College of Sports Medicine, November 8, 2003.